A GIS PLAN TO PROTECT FISH AND WILDLIFE RESOURCES IN THE BIG BEND AREA OF FLORIDA

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Abstract

The Northern Extension of the Florida Turnpike (NEFT) and the Suncoast Expressway are two proposed limited access highways that would connect south Florida and the Tampa Bay area to U.S. 19, the major roadway running through the coastal Big Bend area of north Florida. The parties to a mediation process designed to resolve conflicts over the siting of the NEFT recognized that these new highways will result in a substantial increase in traffic through the rural Big Bend region. In turn, increased traffic is likely to have secondary impacts on the region=s biological resources as a result of increased tourism, the need for new motels and convenience stores, a higher demand for weekend homes, etc. One result of the mediation process was that the parties signed a multi-agency agreement that established a working group whose charge was to Aidentify the means to protect the integrity of US 19 as an interregional route and to prevent secondary impacts within the US 19 corridor due to increased development pressures.@ The coastal Big Bend region of Florida is one of this state=s most rural and remote areas, where the local economy is dominated by timber, agriculture, commercial and recreational fishing, and tourism. The region=s large inland freshwater swamps, river floodplains, wet pinelands, and hardwood forests drain to the productive estuarine systems of the Gulf of Mexico. These native habitats support important marine fisheries and valuable wildlife resources including the Florida black bear. This project was an attempt to use existing geographic information system (GIS) data layers to identify sensitive biological and ecological resources that may be threatened by increased growth. Specific resources mapped as part of the project include nearshore seagrass beds; buffers along freshwater streams and wetlands draining to the Gulf; coastal buffer zones; endangered, threatened, and rare species habitats; Florida black bear habitat and road kill locations; and public lands. This information was assembled into a common GIS database and distributed on CD-ROM for use with ArcView GIS[8] software. In addition, a set of recommendations was developed for the protection of the region=s ecological resources. This information is being assembled into a final report that will be submitted to the Florida Governor=s Office for implementation by state agencies involved in public land acquisition, land use planning, development regulation, public land management, private landowner incentives, and transportation planning. By identifying sensitive ecological resources early in the road planning process, public agencies and private citizens are in a better position to successfully protect important natural lands, and direct growth away from environmentally sensitive areas.

Introduction

Florida currently has an estimated population of 15.2 million people, and by 2025 the population is projected to grow to 20.7 million (Campbell 1996). If these projections hold true, Florida will go from the 4th to the 3rd most populous state in the nation in the next 25 years. In addition to the resident population, Florida is host to an estimated 42 million tourists each year (Winsberg 1992). Moreover, the state=s highways accommodate a large volume of truck traffic transporting freight for interstate and intrastate commerce. The huge numbers of people living in Florida, visiting the state, or transporting goods each year place a tremendous traffic load on the state=s crowded highways. To meet current and future demand, transportation planners are constantly developing and implementing plans for new transportation facilities.

Over the last decade, two new interstate-level highway segments have been proposed for the north-central portion of the Florida peninsula: the northern extension of the Florida turnpike (NEFT) and the Suncoast Expressway (Figure 1). The NEFT would extend the Florida turnpike for about 65 km (40 miles) from its current terminus at Wildwood in central Florida and would link with US 19, the principal north-south artery along Florida=s west coast. The principal purpose for the NEFT is to alleviate traffic on I-75 in northern Florida. The Suncoast Expressway would parallel US 19 from Tampa north for a distance of 103 km (64 miles), linking up with US 19 approximately 24 km (15 miles) south of the proposed terminus of NEFT. The purpose of the Suncoast expressway is to alleviate traffic on the heavily congested US 19 from Tampa to Crystal River. These new highways would also improve ground transportation between the American Midwest and Central and South Florida.

Once completed in about 10 years, these new highways are expected to generate a large increase in traffic on US 19 through the rural and ecologically sensitive Big Bend region of north Florida. Not only will these highways facilitate travel from other parts of the nation to south Florida, they will also improve recreational access to the extensive natural areas of the Big Bend region by residents of central and south Florida. In turn, increased traffic and improved recreational access may be expected to result in secondary growth and adverse cumulative impacts on the region=s ecological resources. New gas stations, convenience stores, shopping centers, restaurants, motels, second homes, roads, etc., will need to be constructed to serve the needs of travelers, tourists, and new residents over the next 25 years.

These issues came to light during a multi-agency mediation process designed to resolve conflicts that arose over the siting of the NEFT. One result of the mediation process was that the affected agencies signed an agreement that established a working group whose charge was to Aidentify the means to protect the integrity of US 19 as an interregional route and to prevent secondary impacts within the US 19 corridor due to increased development pressures.@ Our responsibility in the working group was to identify the important biological and ecological resources that are priorities for protection in the Big Bend region. The intent was that the results of this study could be used to begin planning for the growth of this region in an environmentally sound manner before these new transportation projects come on line in the next 10 years. Once important areas are identified, land use planners will have a 10 year window in which to educate local governments as to the resource values of their area and the impacts that are likely to occur, and to set in place the land use plans, local ordinances, and other tools needed to direct growth in a manner that preserves the biological diversity of the region. The study used geographic information system (GIS) technology and existing databases to prepare maps of high priority ecological resources for protection.

Study Area Description

For the purposes of this study, the Big Bend region of Florida includes all of Levy, Gilchrist, Dixie, Lafayette, Taylor, Madison, and Jefferson counties (Figure 2), the seven counties most affected by the expected increase in traffic along US 19. The region is one of the most rural and remote areas remaining in the state, with urban areas accounting for only 5.2% (Table 1). The local economy is dominated by timber and forest products, agriculture, commercial and recreational fishing, and tourism. The area is characterized by diverse plant communities and habitat types. Wetlands cover 33% of the landscape (Table 1) and include hardwood and cypress (*Taxodium* spp.) swamps, bayheads, freshwater marshes, hydric hardwood hammocks, pond pine (*Pinus serotina*) flatwoods, and coastal salt marsh. Many upland areas have been converted to planted slash pines (*P.*

elliottii) by the forest industry, and pine plantations are now the predominant land use in the region, accounting for 37% of the landscape (Table 1). Natural uplands communities, such as sandhills, mesic and xeric hardwood hammocks, xeric oak (*Quercus* spp.) scrub, and sand pine scrub (*P. clausa*), once accounted for 37% but now cover only 12% of the Big Bend (Table 1). Sandhills, which historically covered 17% of the region, have been reduced to only 0.27% of the area.

The principal streams flowing through or draining the region include the Suwannee, Econfina, Steinhatchee, Aucilla, and Waccassa rivers. These rivers drain uplands and large forested wetlands to the Apalachee Bay and Gulf of Mexico along the coast of Jefferson, Taylor, Dixie and Levy counties. The entire coastline of the region is fringed by a vast salt marsh system dominated by black needelrush (*Juncus roemerianus*). The waters of Apalachee Bay are very shallow and slope very gradually to deeper offshore waters of the Gulf of Mexico. The clear waters and shallow bottoms of Apalachee Bay support an extensive and productive seagrass bed system that is second in area only to Florida Bay.

The native habitats of the Big Bend support a diverse and valuable array of fish and wildlife. Estuarine areas directly support important sport and commercial marine fisheries for spotted seatrout (*Cynoscion nebulosus*), red drum (*Sciaenops ocellatus*), gulf flounder (*Paralichthys albigutta*), striped mullet (*Mugil cephalus*), bay scallops (*Argopecten irradians*), oysters *(Crassostrea virginica*), blue crabs (*Callinectes sapidus*), and stone crabs (*Menippe mercenaria*). Also, a successful and growing commercial aquiculture fishery for clams (*Mercenaria* spp.) has been established in several areas. The large swamps, hardwood hammocks, and pinelands provide prime habitat for game animals including the white-tailed deer (*Odocoileus virginiana*), wild turkey (*Meleagris gallopavo*), and gray squirrel *(Sciurus carolinensis*). Important habitat is also provided for many rare species and others listed by the Florida Fish and Wildlife Conservation Commission as endangered, threatened, or species of special concern including the Florida black bear (*Ursus americana flordidanus*), red-cockaded woodpecker (*Picoides borealis*), Florida scrub jay (*Aphelocoma coerulescens*), and wood stork (*Mycteria americana*) (Table 2).

Geographic Information System Data Layers

Geographic information system (GIS) technology was used for the task of identifying and prioritizing ecological resources likely to be at risk from the secondary and cumulative impacts of these two new expressways in north Florida. For this project, all GIS analyses were performed using ArcView GIS[8] 3.1 and the ArcView Spatial Analyst[8] 1.1 extension. Most of the analyses were performed using raster databases and raster modeling techniques. A large number of GIS databases is available that characterize the biological and ecological resources of the state. Available GIS databases used in this project are described below.

Land Cover and Vegetation

A raster database of vegetation and landcover for the state of Florida (Kautz et al. 1993) was used as the source of vegetation information. This database, created from 1985-89 Landsat Thematic Mapper imagery, contains 22 land cover classes. Pixel size is 30 m.

Potential Wildlife Habitat Models

Cox et al. (1994) and J. Cox (unpublished manuscript) created potential habitat models for more than 150 species of Florida wildlife. The species for which potential habitat models have been created include (1) all Florida vertebrates listed as endangered species, threatened species, or species of special concern by the State of Florida or the federal government (Logan 1997), (2) all Florida vertebrates listed as endangered, threatened, species of special concern, rare, or status undetermined by the Florida Committee on Rare and Endangered Plants and Animals (Humphrey 1992, Moler 1992, Rodgers et al. 1996), and (3) species given a biological score of $\geq$24 by Millsap et al. (1990). All models use 109 m pixels to depict the most likely locations of habitat for each species on a statewide basis. Class codes in the data set are either 0 (i.e., no habitat) or 1 (i.e., potential habitat). A variety of techniques was used to create each of the potential habitat models. The sources of input data included occurrence records from the Florida Natural Areas Inventory, occurrence records from the Florida Fish and Wildlife Conservation Commission=s wildlife observation database, the Florida breeding bird atlas database (Kale et al. 1992), the vegetation data of Kautz et al. (1993), unpublished records from species experts, range maps, and habitat requirements information obtained from the scientific literature. The Big Bend region supports 55 species of wildlife meeting the conditions described above (Table 2), and habitat models are available for most.

Strategic Habitat Conservation Areas

Cox et al. (1994) identified 4.82 million acres of land in Florida that they referred to as Strategic Habitat Conservation Areas (SHCA). SHCAs are privately owned lands that should be protected to ensure the long-term persistence of most components of biodiversity in Florida. Cox et al. (1994) used GIS to create potential habitat maps for a set of focal species of wildlife that were used as indicators of biodiversity. The focal species were evaluated for how well their habitats were already protected on public lands. SHCAs are presumed to be high priorities for protection of biological diversity in Florida.

Seagrass Beds

Vector coverages for the locations of seagrass beds in the nearshore waters of the Gulf of Mexico were obtained from the Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute, Atlas of Marine Resources, Version 1.2 (1998).

Political Boundaries

U.S. Geological Survey (USGS) Digital Line Graph (DLG) vector coverages, digitized from 1:100,000 scale quadrangle maps for the state of Florida, were used for political boundaries.

Roads

Vector coverages for the road network for the region were obtained from the Florida Department of Transportation. The base map for the line work is unknown.

Black Bear Roadkill Locations

Since 1976, the Florida Fish and Wildlife Conservation Commission has been collecting information on the locations, age, and sex of Florida black bears killed on highways as a result of collisions with motor vehicles. This database has been digitized and is used to identify specific stretches of highway where roadway mortality is a problem for the black bear (Gilbert and Wooding 1996).

Public Lands and Lands Proposed for Public Acquisition

The state of Florida has a very active program for the acquisition and management of public lands. The Florida Natural Areas Inventory (FNAI), the unit of The Nature Conservancy responsible for maintaining Florida=s natural heritage database, is under contract to the state of Florida

to maintain statewide vector coverages of the boundaries of lands in public ownership, lands in private ownership dedicated to conservation uses, and privately owned lands proposed for public acquisition. Boundaries of conservation lands and lands proposed for acquisition are typically digitized from 1:24,000 scale USGS topographic maps.

Private Landowner Boundaries

In pursuing biodiversity conservation needs on privately owned lands, it is often easier to deal with a few large private landowners than many owners of small parcels. For this reason, Cox et al. (1994) digitized the boundaries of privately owned lands 130 ha (>320 acres) for 57 Florida counties, including six of the seven counties in the Big Bend study area. Parcel boundaries were transferred by hand from commercially available plat books to 1:126,700 scale county highway maps and then digitized (Cox et al. 1994), but landowner names were not included as an attribute of the boundaries. For this project, the original linework of Cox et al. (1994) was overlaid on the USGS DLG Public Land Survey System coverage for the seven-county study area, and the private landowner boundaries were rectified to the vector coverage and updated using the most recent plat books available. Then, the names of landowners for the parcels >130 ha (>320 acres) in size were added as an attribute of the boundaries. A completely new set of parcel boundaries and landowner names was created for Jefferson County which was not included in the original data set of Cox et al. (1994). The purpose for this part of the project was to facilitate landowner contacts for eventual users of the database.

Hydrography

Vector coverages of streams were obtained from the U.S. Environmental Protection Agency (EPA) river reach file version 3.0 (RF3-Alpha). This data set originated as the hydrography coverage in the USGS 1:100,000 scale DLG files for Florida, but was modified by EPA such that river reaches are now identified with specific river reach identification numbers, and each river reach is defined by nodes placed at the confluence of each tributary to the stream.

Identification of Important Ecological Resources

The GIS data layers described above were used to identify the important ecological areas of the Big Bend region that should be protected from the secondary impacts of increased traffic expected to occur from the completion of the NEFT and Suncoast Expressway. The principal ecological resources of concern include nearshore seagrass beds, streams and wetlands, habitats of rare and imperiled wildlife, and habitat for the Florida black bear. The methods used to identify important areas for each of these components of biodiversity are described in the following sections.

Big Bend Seagrass Beds

Among the most valuable ecological resources of the Big Bend area are the extensive marine seagrass beds found in the nearshore waters of the Gulf of Mexico. Seagrass beds provide critical habitat for many estuarine and marine species of recreational and commercial importance (Livingston 1990). Recreational fishing is a prime attraction of the Big Bend area, and healthy seagrass beds are integral to the sustainability of nature-based tourism in the region.

The key factor in maintaining healthy seagrass beds is water quality, particularly with respect to water clarity and nutrients. The quality of waters overlying the seagrass beds is most influenced by the quality of upland runoff reaching the coast via the streams and rivers draining the region. Thus, maintenance of water quality in the area=s rivers and streams is imperative. To protect in-stream water quality, development should be precluded from stream banks to avoid increases in turbdity and nutrients entering the streams. In addition, wetlands contiguous with streams draining to the Gulf of Mexico should be protected from development because they not only are a major source of water to area streams but also function to filter nutrients, pollutants, and sediments from upland runoff.

Brown et al. (1990) conducted an exhaustive review of the functions of streamside buffer zones for natural communities in east central Florida similar to those found in the Big Bend region. Brown et al. (1990) found that buffer zones in the range of 30-170 m would (1) minimize the effects of groundwater drawdown resulting from ditching near streams, (2) control sedimentation of streams and wetlands, and (3) protect wildlife habitat. With respect to wildlife habitat protection, further studies have indicated that buffer zones of 73 m and 275 m are needed to protect 90% and 100%, respectively, of turtle nest sites around wetlands (Burke and Gibbons 1995), buffer zones of 164 m around wetlands should protect 95% of the upland habitats required by salamanders (Semlitsch 1998), and streamside management zones 40-140 m wide, but averaging 100 m wide (i.e., 50 m on either side of a stream), support high densities of gray squirrels (Warren and Hurst 1980). Riparian buffer strips also function as movement corridors for forest birds and several species of rodents (Machtans et al. 1996), but no buffer widths have been recommended as optimal to provide for the movement needs of birds and mammals.

Based on these reviews of the literature, we concluded that an upland buffer zone of 100 m around all wetlands and along all streams that drain to the Gulf of Mexico should be sufficient to protect water quality and quantity in these systems. Maintenance of in-wetland and in-stream water quality and quantity should, in turn, provide water quality protection to nearshore seagrass beds, thereby preserving their ecological values. In addition, 100 m buffers also provide a variety of benefits for many species of wildlife.

Our GIS model of areas that need to be protected to maintain the quality of offshore waters employed the following steps:

1. All streams draining to the Gulf of Mexico in the Big Bend study area were extracted from the EPA river reach file.
2. The vegetation map of Kautz et al. (1993) was reclassified such that only wetlands remained.
3. The EPA river reach file was intersected with the wetlands map, and contiguous wetlands intersecting the streams were retained. The purpose of this step was to isolate only wetlands and associated streams that drain to the Gulf of Mexico as priorities for water quality protection.
4. A 100 m buffer was placed on either side of all streams and around the margins of all wetlands that drain to the Gulf of Mexico. The purpose of this step was to identify buffer areas that should be protected from development in order to ensure in-stream water quality, maintain existing flows, and provide for wildlife habitat needs.

In addition to protecting streams and wetlands that drain to the Gulf of Mexico, an upland buffer along the entire length of the coast would also be helpful in protecting the water quality of the seagrass beds from developments that might eventually occur immediately along the coast. Unfortunately, we could find no hard data to indicate how wide a coastal buffer should be to protect offshore grassbeds. In the absence of hard data, we looked to the St. Marks National Wildlife Refuge (NWR) in Jefferson and adjacent Wakulla County as an example of a coastal buffer that seems to provide adequate water quality protection. St. Marks NWR has a land area of 26,044 ha (64,239 acres) and extends along the shoreline of Apalachee Bay for a distance of about 51 km (32 miles). Water quality offshore of the St. Marks NWR remains high, and the seagrass beds are productive. The refuge maintains upland habitats immediately inland of the coast in a relatively natural condition, apparently producing naturally high quality waters in the streams flowing through the refuge and discharging to the Gulf of Mexico. The northern boundary of St. Marks NWR

extends an average of 2.4 km (1.5 miles) inland from the salt marsh/upland forest interface. Using the St. Marks NWR case as a model for success, we propose a coastal buffer of 2.4 km (1.5 miles) extending inland from the edge of the salt marsh along the entire length of the Big Bend study area. Our model for a 2.4 km (1.5 mile) coastal buffer was created using the following steps:

1. The vegetation map of Kautz et al. (1993) as used to locate the line separating salt marsh and upland plant communities.
2. The line identified in Step 1 was buffered inland for a distance of 2.4 km (1.5 miles) to define the landward limits of the coast buffer strip.

While most of the shoreline along the Big Bend coast already is in public ownership, the proposed coastal buffer would protect the remaining undeveloped areas immediately along the coast from future development and potential adverse impacts to water quality.

In summary, the quality of waters overlying the seagrass beds of the Big Bend region could be protected by the following: (1) a 100 m buffer along all streams draining to the Gulf of Mexico, (2) a 100 m upland buffer surrounding all wetlands contiguous with streams that drain to the Gulf, and (3) a 2.4 km (1.5 mile) coastal buffer extending inland from the salt marsh/upland interface. These ecological resources are depicted in Figure 3. The best methods for protection of these areas would be through regulations pertaining to dredging and filling and through comprehensive land use planning to protect upland buffers.

Endangered Species

Three species of wildlife listed as endangered by the state of Florida and the U.S. Fish and Wildlife Service inhabit the seven-county study area: wood stork, peregrine falcon, and saltmarsh vole (Logan 1997). Species are listed as endangered when their populations are so low that the species are considered to be in imminent danger of extinction. Of the three endangered species occurring in the study area, wood storks are of greatest concern. Wood storks nest colonially and forage in wetlands within 30 km of colony sites during the nesting season. Since habitat loss is the principal threat to wood storks, all wetlands within 30 km of nesting colonies need to be protected to ensure long-term nesting success and survival of wood storks. Using these features of wood stork life history, Cox et al. (1994) mapped the critical habitats of wood storks throughout Florida. The map of critical wood stork habitats is incorporated into our map of important ecological resources for the Big Bend region under the assumption that wood stork are an important species that cannot tolerate additional habitat loss. Many of the wetlands needed by wood storks are included within the wetlands that should be protected to maintain water quality of the seagrass beds.

The habitat protection needs of the other two endangered species that occur in the study area are minimal. Peregrine falcons occur in the region only during spring and fall migration and throughout the winter months. During these times, they prey primarily on shorebirds congregating on oyster bars, mud bars, tidal flats, and sand beaches immediately along the coast. Most of these habitats are already in public ownership, so no additional habitat protection is needed for peregrine falcons. The Florida salt marsh vole is found only in a small area of salt marsh wetlands near Cedar Key. While these wetlands are not in public ownership, the sites could be protected from development impacts through development regulation or comprehensive land use planning. The protection of coastal salt marshes as part of a seagrass bed protection plan would also protect salt marsh vole habitat.

Threatened Species, Species of Special Concern, and Rare Nongame Wildlife

Additional species of wildlife of concern in the Big Bend region include 10 species listed as threatened, 16 species listed as species of special concern, and 26 rare species of nongame wildlife. These 52 species, plus the three endangered species discussed above (Table 2), include all taxa of vertebrates found in the study area that have been identified as having some kind of conservation need (Millsap et al. 1990, Humphrey 1992, Moler 1992, Rodgers et al. 1996, Logan 1997). To identify important habitats needed to protect these species in the Big Bend region, the following steps were taken:

1. Habitat models for the 10 threatened species (Cox et al. 1994, J. Cox unpublished manuscript) were overlaid to identify areas that would support the greatest number of threatened species.
2. Habitat models for the remaining 42 species also were overlaid to identify habitat hot spots for the remaining rare and imperiled vertebrates in the study area..

Step 1 identified the sandhill and scrub habitats of Levy and Gilchrist counties as hot spots for the threatened species of the region. Threatened species are in imminent danger of becoming endangered if current population trends continue, and habitat loss is the principal reason most of these species are listed as threatened. We presume that the habitats of threatened species constitute ecologically significant resource worthy of protection, and, therefore, the sandhill and scrub habitats of Levy and Gilchrist counties are important areas that should be protected from further development. Step 2 resulted in the identification of most remaining areas of natural habitat in the region as supporting at least one rare species. However, habitat hot spots for species of special concern and other rare and imperiled wildlife were primarily in the sandhills and scrubs of Levy and Gilchrist counties. Because the habitat modeling for both threatened and other rare and imperiled species of wildlife identified the sandhill and scrub habitats in the region as hot spots, our map of ecologically significant resources ranks these areas as high priorities for protection (Figure 4).

Florida Black Bear

The Florida black bear, listed as threatened by the state of Florida (Logan 1997), presents a special case for protection from the impacts of secondary development. The black bear is a very mobile, wide-ranging species that requires extensive areas of forested habitat. Home range sizes of adult males average around 17,000 ha (42,000 acres), and the largest home range size observed in Florida was 45,750 ha (113,000 acres) (Maehr and Wooding 1992). The two most significant issues with respect to black bear conservation are habitat loss and roadkill mortality. These issues are dealt with separately in the following sections.

Black Bear Habitat - The extensive forested uplands and wetlands of the Big Bend region appear to provide a large area of suitable black bear habitat, yet black bears currently are present only in the western-most portion of the study area. Conjecture has it that black bears have been eliminated from the region due to past over-hunting. At the present time, the Apalachicola National Forest (NF) 32 km (20 miles) to the west of the study area supports the largest population of black bears protected by public lands in Florida (Cox et al. 1994). In recent times, the black bear population of the Apalachicola NF has been expanding to the east, apparently because the population is increasing in response to the termination of black bear hunting seasons in Florida. The population increase is evidenced by the increasing number of road-killed black bears in southern Jefferson County, the western-most county in the study area.

The significance of certain areas of Jefferson and Taylor counties to the expanding black bear population was recognized by Cox et al.

(1994) who designated these lands as Strategic Habitat Conservation Areas (SHCA) for black bears (Figure 5). Areas designated as SHCAs are privately owned lands that are the highest priorities for protection in order to ensure that sufficient habitat is available to meet the long-term needs of black bears. We presume that the SHCAs identified by Cox et al. (1994) are of prime importance for black bear conservation, and, therefore, these areas should be included in any map of ecologically significant resources for the study area.

As part of their effort to prioritize black bear habitats for conservation, Cox et al. (1994) created a map of black bear habitat ranked according to habitat quality, proximity to public lands, density of roads, and large landownership patterns. The ranked habitat map shows that most of the non-urbanized areas of the Big Bend region qualify as black bear habitat (Figure 6). The highest ranked habitats occur between US 19 and the Gulf coast. Given the evidence that the black bear population is expanding to the east from Apalachicola NF and that habitats in the Big Bend region are suitable for black bears, there is value in formulating a conservation plan for black bear habitat to allow bears to eventually reoccupy available habitats. In addition, repopulation in the region would eventually allow for a connection with a small isolated population of black bears in the Chassahowitzka area immediately to the south of the study area. The principal problem with formulating a habitat conservation plan for black bears is that there is so much apparently suitable habitat in the region that outright purchase by public agencies is unfeasible. Perhaps the best solution to the conservation of black bear habitat is to maintain the existing landscape for timber production. Methods for accomplishing this are outlined in the recommendations section.

Black Bear Roadkill Mortality - The greatest known source of mortality to black bears is collisions with motor vehicles. The greatest number of black bear roadkills in the region in recent years has occurred in Jefferson County along US 19 and along US 98 just west of the Aucilla River (Figure 5). Increased highway traffic on US 19 will undoubtedly increase the amount of traffic in Jefferson County, thereby increasing the likelihood of future roadkills along these stretches of road. In addition, if black bears continue to expand into the habitats of the Big Bend region as expected, there is a greater probability that black bear roadkills will begin to occur throughout the region. One possible way to reduce current roadkills is to mitigate the impacts of the NEFT and the Suncoast Expressway by constructing bear underpasses at the problem areas of US 98 and US 19 in Jefferson County with first priority given to US 98.

Ecological Resource Protection Summary

In this project, we have attempted to use GIS technology and best available data to identify the important ecological resources of the seven-county study area of the Big Bend region (Figure 7). These are the areas of highest value that should be protected from the adverse and cumulative impacts of secondary development due to the eventual completion of the Northern Extension of the Florida Turnpike and the Suncoast Expressway and the resultant increase in traffic on US 19. Priorities for protection include: (1) the Big Bend seagrass beds; (2) 100 m buffers around all rivers, streams, and contiguous wetlands that drain to the Gulf of Mexico; (3) a 2.4 km (1.5) mile coastal buffer; (4) habitats of endangered species, especially the wood stork; (5) sandhill and scrub habitats that support large numbers of rare and imperiled species; and (6) Strategic Habitat Conservation Areas for black bears in Jefferson and Taylor counties. Habitats of lower priority for protection include the pine flatwoods and forested wetlands of the region that are primarily in timber use. These areas are important to the wide-ranging black bear and also support many other species of wildlife.

Ecological Resource Protection Recommendations

The ecologically important areas identified in this project can be protected through a variety of techniques. The principal techniques currently available include *land acquisition, land use planning, development regulation, private landowner incentives*, and *public land management*. These techniques could be employed by agencies of state and local governments as they discharge their routine duties over the next 20-30 years. Specific recommendations are listed below.

Land Acquisition

Recommendation 1: Remaining scrub and sandhill habitat in Levy and Gilchrist counties should be acquired by the State. These areas are the highest priorities for outright purchase as they support the rarest species and most sensitive natural communities in the region, and they are not likely to be adequately protected through any other means. New land acquisition projects should be designed to protect these areas, and proposals should be submitted to agencies currently involved in the State=s various land acquisition programs, including Conservation and Recreation Lands (CARL), Preservation 2000 (P2000), Save Our Rivers (SOR), and Florida Forever.

Recommendation 2: Black bear Strategic Habitat Conservation Areas in Jefferson and western Taylor counties should be acquired by the State. At the present time, these are the most important areas for the black bears in the Big Bend region. Several existing CARL and SOR projects are included within this area.

Recommendation 3: Privately owned lands within 2.4 km (1.5 miles) of the coast from Jefferson to Levy county should be acquired by the State. This acquisition would connect existing parcels of public land to provide a continuous buffer along the entire coast of the region. New land acquisition project proposals would have to be developed to complete the buffer.

Recommendation 4: Devil=s Hammock CARL/SOR project in Levy County should be acquired to provide a buffer to protect the Waccasassa River and Waccasassa Bay.

Recommendation 5: Conservation easements on large privately owned timber lands should be purchased to protect black bear habitat and to maintain enough habitat in the region to allow black bear populations to expand over time. Conservation easements would allow for continuation of existing timber operations but would preclude eventual conversion of the lands to urban uses. Areas suitable for the purchase of conservation easements for black bears are depicted in order of priority in Figure 8.

Land Use Planning

Recommendation 1: County comprehensive land use plans should be revised to prescribe conservation-oriented land uses for the highest priority ecological resources identified in this project. Land use plans should specifically include 100 m buffer zones along all streams and around all wetlands discharging to the Gulf of Mexico.

Recommendation 2: County governments should ensure that lands zoned for timber use in their comprehensive land use plans remain in timber use and should resist proposals to rezone timber lands for development.

Recommendation 3: The Florida Department of Community Affairs (i.e., the state growth management and land use planning agency), local governments, and other state agencies should use the results of this work in the review of new large scale residential and commercial developments proposed for the Big Bend region.

Recommendation 4: The North Central Florida, Apalachee, and Withlacoochee Regional Planning Councils should revise their Strategic Regional Policy Plans such that their maps of Natural Resources of Regional Significance include the high priority ecological resources identified in this project.

Development Regulation

Recommendation 1: The information presented here should be used in the evaluation of Environmental Resource Permits (i.e., dredge and fill permits) for projects that affect surface waters or involve wetland impacts. Of special concern would be direct impacts to streams and wetlands that discharge to the Gulf of Mexico and impacts within the 100 m buffer zones around these streams and wetlands.

Recommendation 2: The dredge and fill permitting rules of the Suwannee River Water Management District should be revised to provide special protection within 100 m buffer zones of streams and wetlands that drain to the Gulf of Mexico.

Recommendation 3: The Florida Division of Forestry should work to ensure that Silvicultural Best Management Practices are required within the 100 m buffer zones of all streams and wetlands draining to the Gulf of Mexico to protect water quality of offshore seagrass beds.

Recommendation 4: Black bear underpasses should be installed on US 98 and US 19 in Jefferson County as mitigation for increased traffic flow due to the Northern Extension of the Florida Turnpike and Suncoast Expressway. US 98 is the highest priority for an underpass.

Private Landowner Incentives

Recommendation 1: Local or state governments could provide tax breaks to landowners who maintain their lands in conservation uses. (Note: this type of incentive may not be acceptable to local governments due to loss of tax revenues.)

Recommendation 2: Regulatory agencies involved in Environmental Resource Permitting could provide regulatory relief to landowners in exchange for conservation easements or donations of significant resources to public agencies or non-profit private conservation organizations.

Public Land Management

Recommendation 1: Public land managers should manage lands under their jurisdiction in a manner that sustains the ecological resources identified in this project.

Conclusion

The information developed for this project was assembled into a common GIS database and distributed on CD-ROM to state and federal agencies, biological consultants, and members of the public. The data are compatible for use with ArcView GIS[8] software. In addition, the parties to the multi-agency agreement are incorporating this information, including recommendations, into a final report that will be submitted to the Florida Governor=s Office for implementation by state agencies involved in public land acquisition, land use planning, development regulation, public land management, private landowner incentives, and transportation planning. By identifying sensitive ecological resources early in the road planning process, public agencies and private citizens are in a better position to successfully protect important natural lands and direct growth away from environmentally sensitive areas while accommodating the need for expanded transportation systems.

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Table 1. Land use and land cover statistics for the seven counties in the Big Bend study area based on 1996 aerial photography.

Land Use Class	Area (ha)	Area (acres)	%
Disturbed Lands			
Pine Plantations	487,194	1,203,856	37.29
Agriculture	163,866	404,914	12.54
Urban	67,731	167,364	5.18
Mining	1,332	3,291	0.10
Exotic	1,535	3,793	0.12
Disturbed Lands Subtotal	721,658	1,783,218	55.00
Natural Uplands			
Upland Hardwoods	101,710	251,325	7.78
Pine Flatwoods/Pines	26,814	66,257	2.05
Xeric Oak	14,012	34,624	1.07
Shrub Prairie	10,456	25,837	0.80
Sandhill	3,527	8,715	0.27
Sand Pine Scrub	267	660	0.02
Coastal Strand	185	457	0.01
Herbaceous Prairie	107	264	0.01
Mixed Hardwood-Pine	88	217	0.01
Natural Uplands Subtotal	157,166	388,356	12.03
Forested Wetlands			
Mixed Hardwood Swamp	299,487	740,032	22.92
Pond Pine/White Cedar	33,000	81,543	2.53
Cypress Swamp	27,120	67,014	2.08
Shrub Swamp	12,753	31,513	0.98
Bay Swamp	324	801	0.02
Mangrove Swamp	7	17	0.00
Forested Wetlands Subtotal	372,691	920,920	28.53
Non-forested Wetlands			
Salt Marsh	31,705	78,343	2.43
Freshwater Marsh	12,683	31,340	0.97
Non-vegetation Wetland	9,118	22,531	0.70
Aquatic Bed	1,474	3,642	0.11
Non-forested Wetlands Subtotal	54,980	135,856	4.21
Total	1,306,495	3,228,350	100

Table 2. Rare and imperiled wildlife of the Big Bend region of Florida. The habitat protection needs of these species were evaluated using potential habitat models appearing in Cox et al. (1994) and created by Cox (unpublished manuscript).

Common name (*Scientific name*)	List Status State/Federal	FCREPA	Biological Score
Wood stork (*Mycteria americana*)	E/E	E	23
Peregrine falcon (*Falco peregrinus tundrius*)	E/--	E	24
Salt marsh vole (*Microtus pennsylvanicus dukecampbelli*)	E/E	E	27
Eastern indigo snake (*Drymarchon corais couperi*)	T/T	S	25
Short-tailed snake (*Stilosoma extenuatum*)	T/--	T	30
Bald eagle (*Haliaeetus leucocephalus*)	T/--	T	26
Southeastern kestrel (*Falco sparverius paulus*)	T/--	T	23
Piping plover (*Charadrius melodus*)	T/T	E	35
Least tern (*Sterna antillarum*)	T/--	T	24
Florida sandhill crane (*Grus canadensis pratensis*)	T/--	T	33
Red-cockaded woodpecker (*Picoides borealis*)	T/E	E	30
Florida scrub jay (*Aphelocoma coerulescens*)	T/T	T	30
Florida black bear (*Ursus americanus floridanus*)	T/--	T	33
Gopher frog (*Rana areolata*)	S/--	T	25
Suwannee cooter (*Pseudemys concinna suwanniensis*)	S/--	S	30
Gopher tortoise (*Gopherus polyphemus*)	S/--	T	27
Alligator snapping turtle (*Macroclemys temminckii*)	S/--	S	17
Florida pine snake (*Pituophis melanoleucus mugitis*)	S/--	U	24
American oystercatcher (*Haematopus palliatus*)	S/--	T	29
Brown pelican (*Pelecanus occidentalis*)	S/--	T	24
Wakulla seaside sparrow (*Ammodramus maritimus junicolus*)	S/--	S	24
Tricolored heron (*Egretta tricolor*)	S/--	R	17
Little blue heron (*Egretta caerulea*)	S/--	S	23
Snowy egret (*Egretta thula*)	S/--	R	17
White ibis (*Eudocimus albus*)	S/--	S	13
Limpkin (*Aramus guarauna*)	S/--	S	22
Marian=s marsh wren (*Cistothorus palustris marianae*)	S/--	S	20
Sherman=s fox squirrel (*Sciurus niger shermani*)	S/--	T	24
Homosassa shrew (*Sorex longirostris eionis*)	S/--	**B**	30
Short-tailed hawk (*Buteo brachyurus*)	--/--	R	36
Striped newt (*Notophthalmus perstriatus*)	**B**/--	R	29
Cedar Key mole skink (*Eumeces egregius insularis*)	**B**/--	R	33
Florida scrub lizard (*Sceloporus woodi*)	**B**/--	T	27
Ornate diamondback terrapin (*Malaclemys terrapin macrospilota*)	**B**/**B**	**B**	30
Peninsula crowned snake (*Tantilla relicta relicta*)	**B**/--	**B**	33
Central Florida crowned snake (*Tantilla relicta neilli*)	**B**/--	**B**	31
Eastern diamondback rattlesnake (*Crotalus adamanteus*)	**B**/--	**B**	24
American swallowtailed kite (*Elanoides forficatus*)	**B**/--	T	30
Black rail (*Laterallus jamaicensis*)	**B**/--	R	31
Wilson=s plover (*Charadrius wilsonia*)	**B**/--	S	14
Black-bellied plover (*Pluvialis squatarola*)	**B**/--	**B**	24
American avocet (*Recurvirostra americana*)	**B**/--	S	14
Marbled godwit (*Limosa fedoa*)	**B**/--	**B**	24
Whimbrel (*Numenius phaeopus*)	**B**/--	**B**	34
Red knot (*Calidris canutus*)	**B**/--	**B**	26
Sanderling (*Calidris alba*)	**B**/--	**B**	24
Semipalmated sandpiper (*Calidris pusilla*)	**B**/--	**B**	26
Western sandpiper (*Calidris mauri*)	**B**/--	**B**	24
White-rumped sandpiper (*Calidris fuscicollis*)	**B**/--	**B**	26
Pectoral sandpiper (*Calidris melanotos*)	**B**/--	**B**	28
Short-billed dowitcher (*Limnodromus griseus*)	**B**/--	**B**	26
Royal tern (*Sterna maxima*)	**B**/--	**B**	26
Caspian tern (*Sterna caspia*)	**B**/--	S	21
Sandwich tern (*Sterna sandvicensis*)	**B**/--	S	19
Florida mink (*Mustela vison lutensis*)	**B**/--	**B**	33

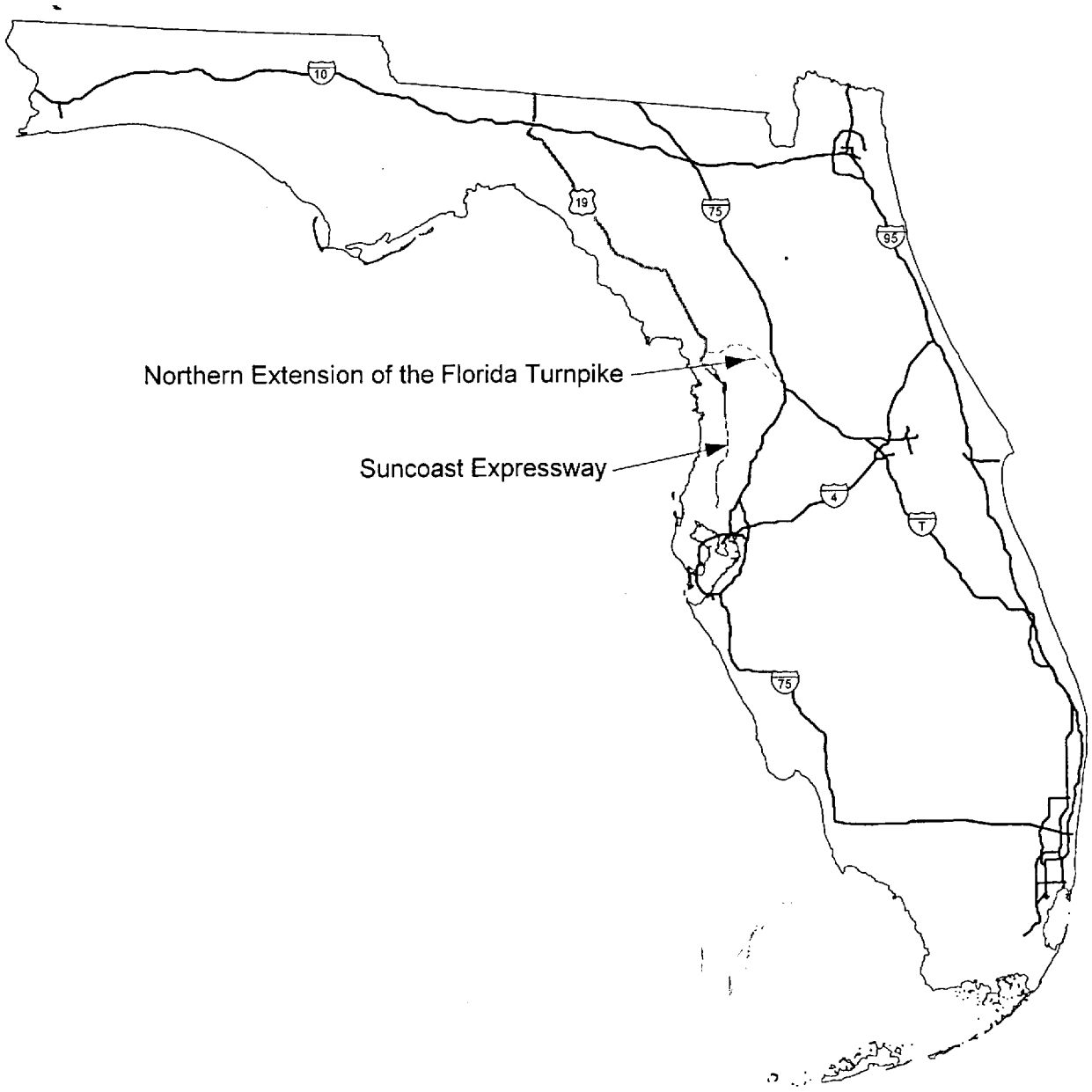

Figure 1. The Florida interstate highway system. The proposed Northern Extension of the Florida Turnpike and the Suncoast Expressway would extend the interstate system to US 19 in west central Florida.

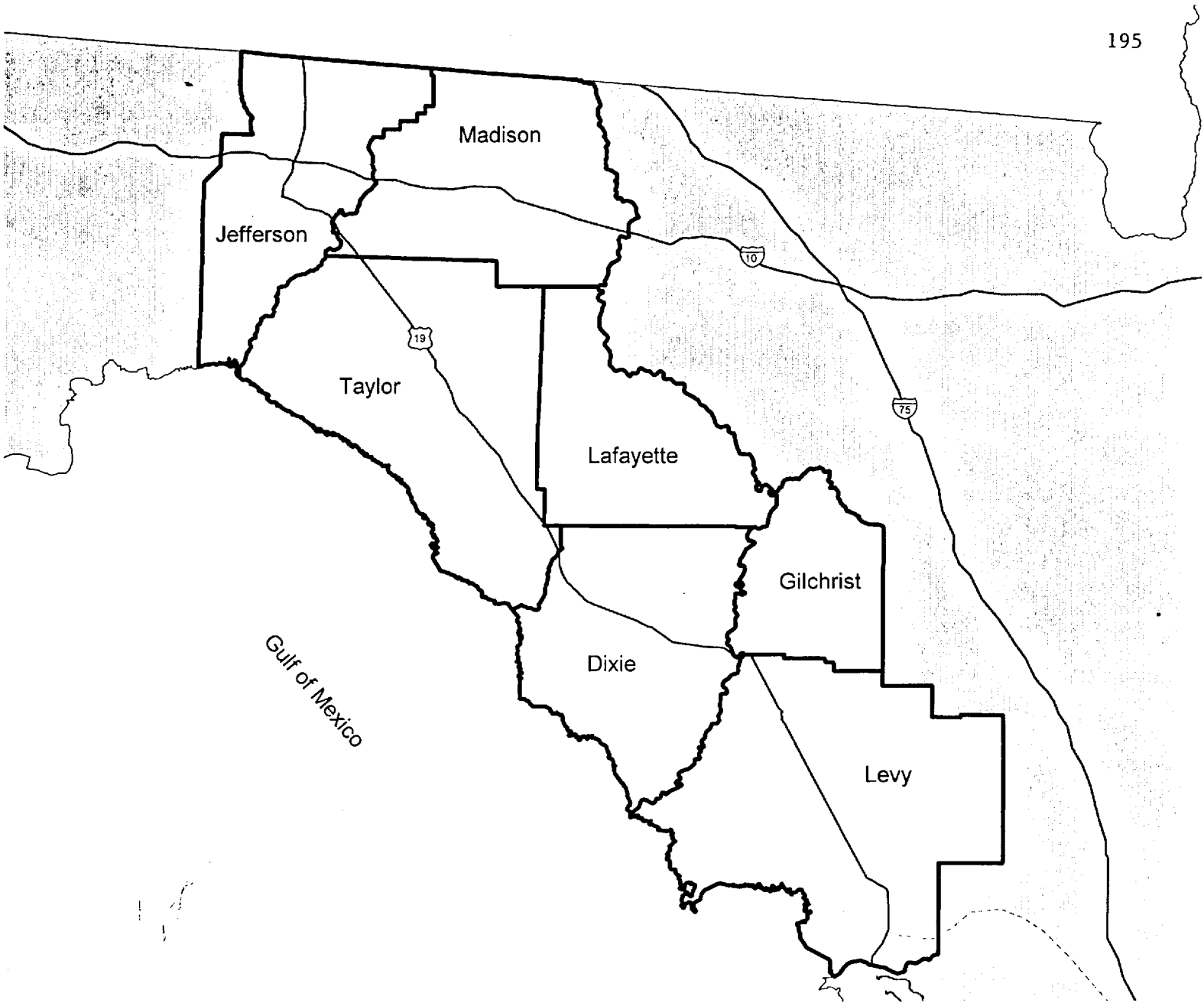

Figure 2. Big Bend study area. The eocological resources of these seven counties will experience the secondary impacts of increased traffic on US 19.

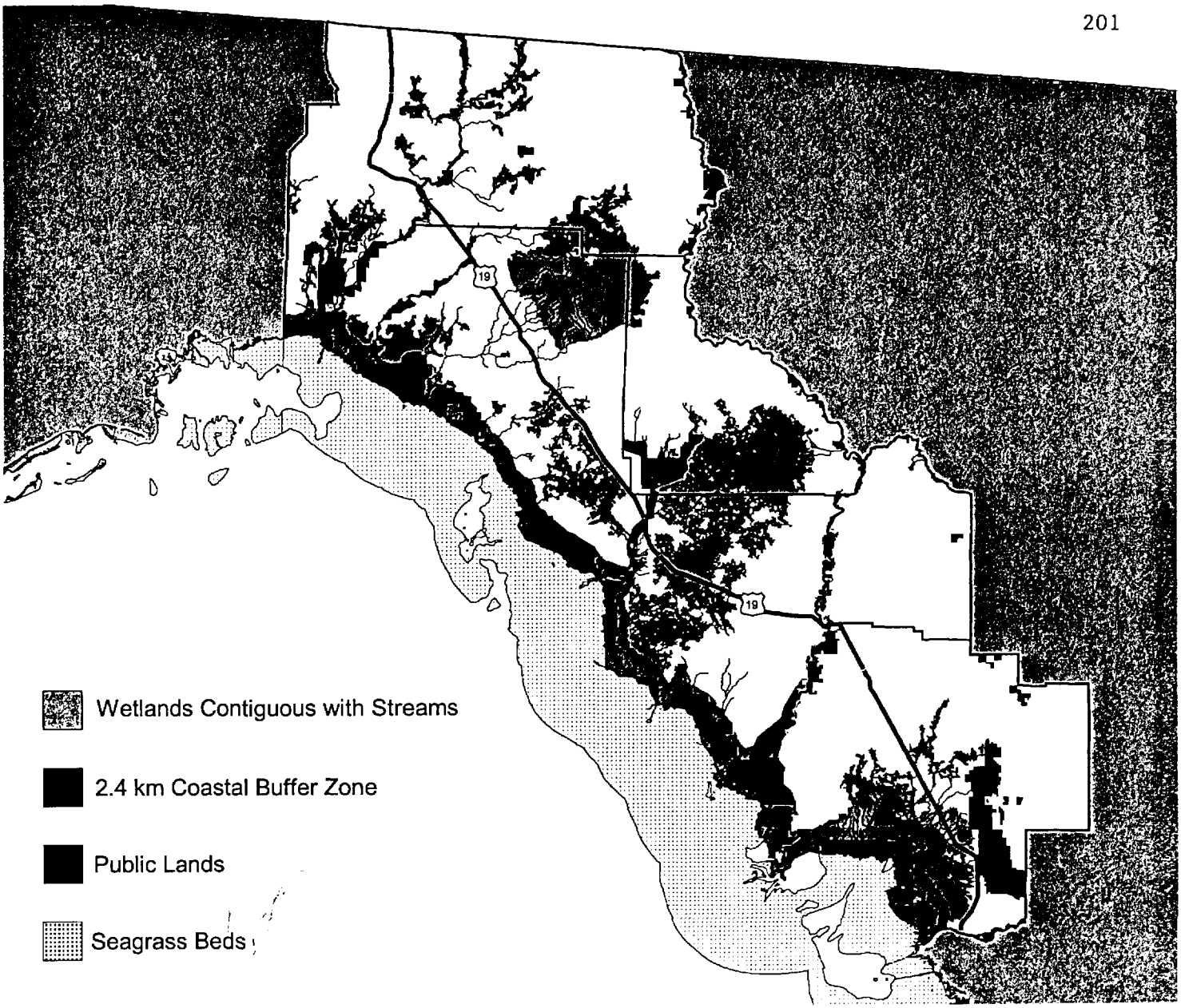

Figure 3. Ecological resources that protect the seagrass beds of the Gulf of Mexico: (1) 100 m buffers along streams that drain to the Gulf of Mexico, (2) 100 m buffers around wetlands that drain to streams, (3) 2.4 km coastal buffer zone, and (4) public lands.

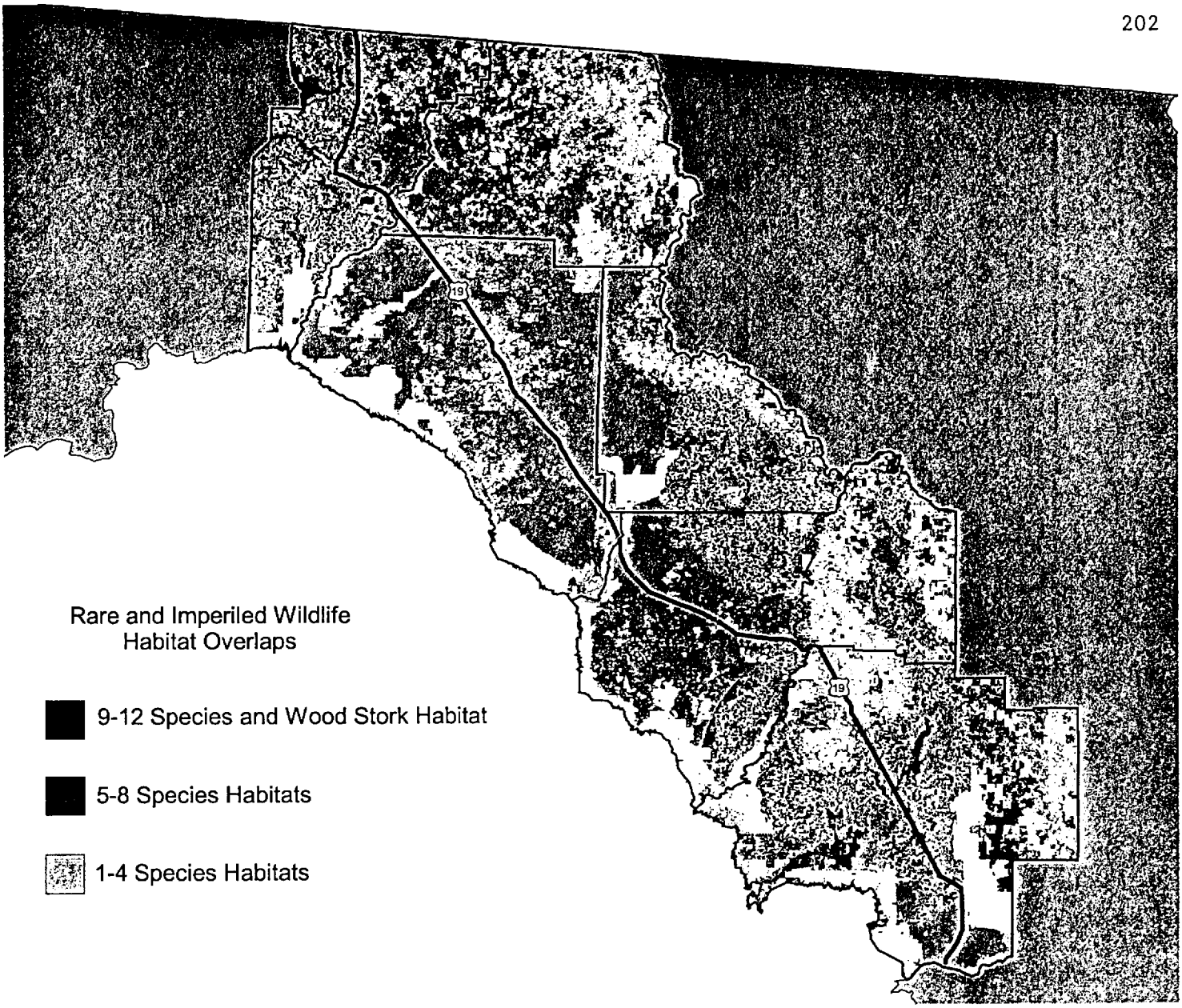

Figure 4. Habitat overlaps of 38 rare and imperiled species of wildlife that are found in the Big Bend region. The most important habitats are found in the sandhills and scrubs of Levy and Gilchrist County and wetlands used by wood storks.

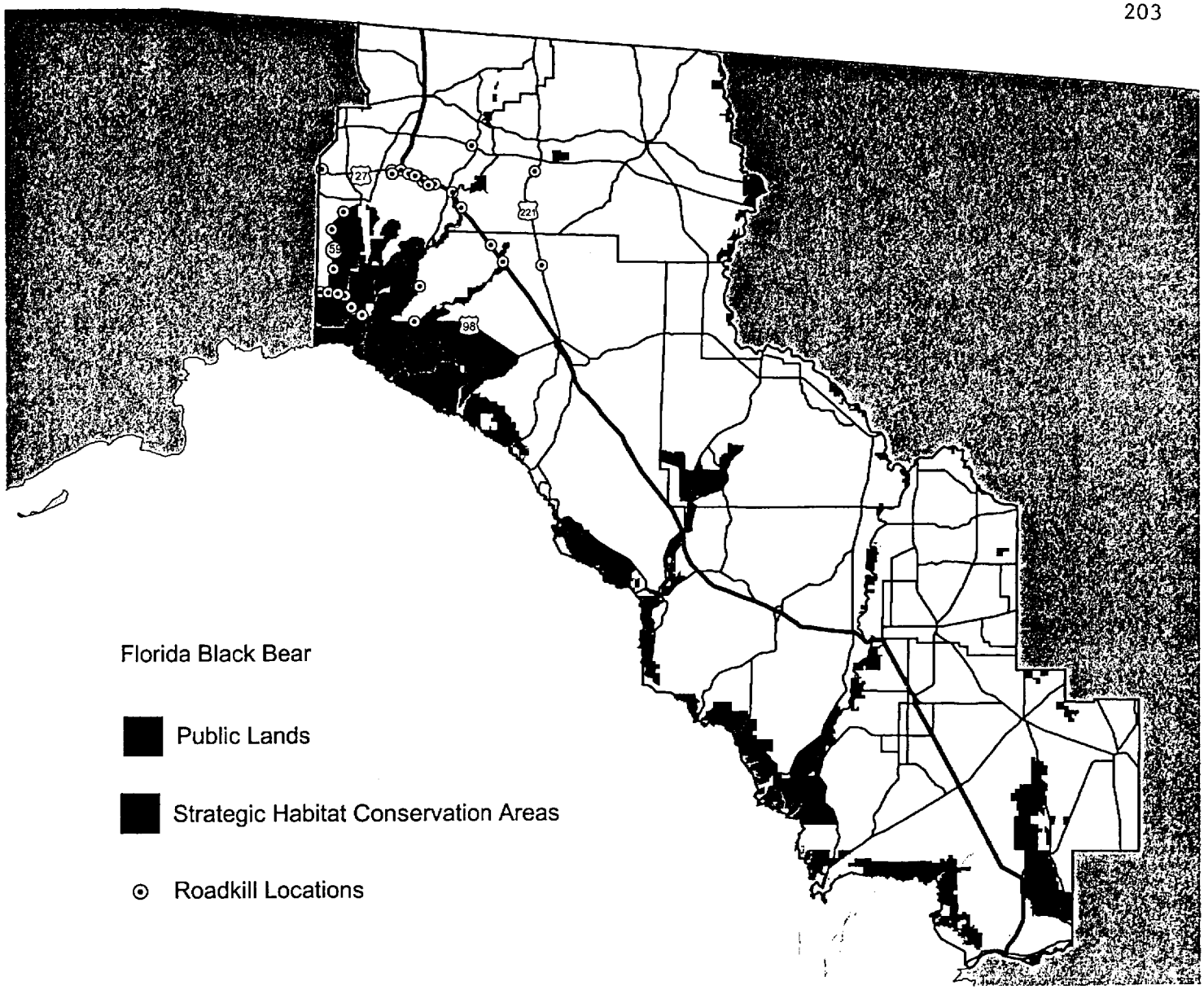

Figure 5. Florida black bear Strategic Habitat Conservation Areas (Cox et al. 1994) and roadkill locations in the Big Bend region.

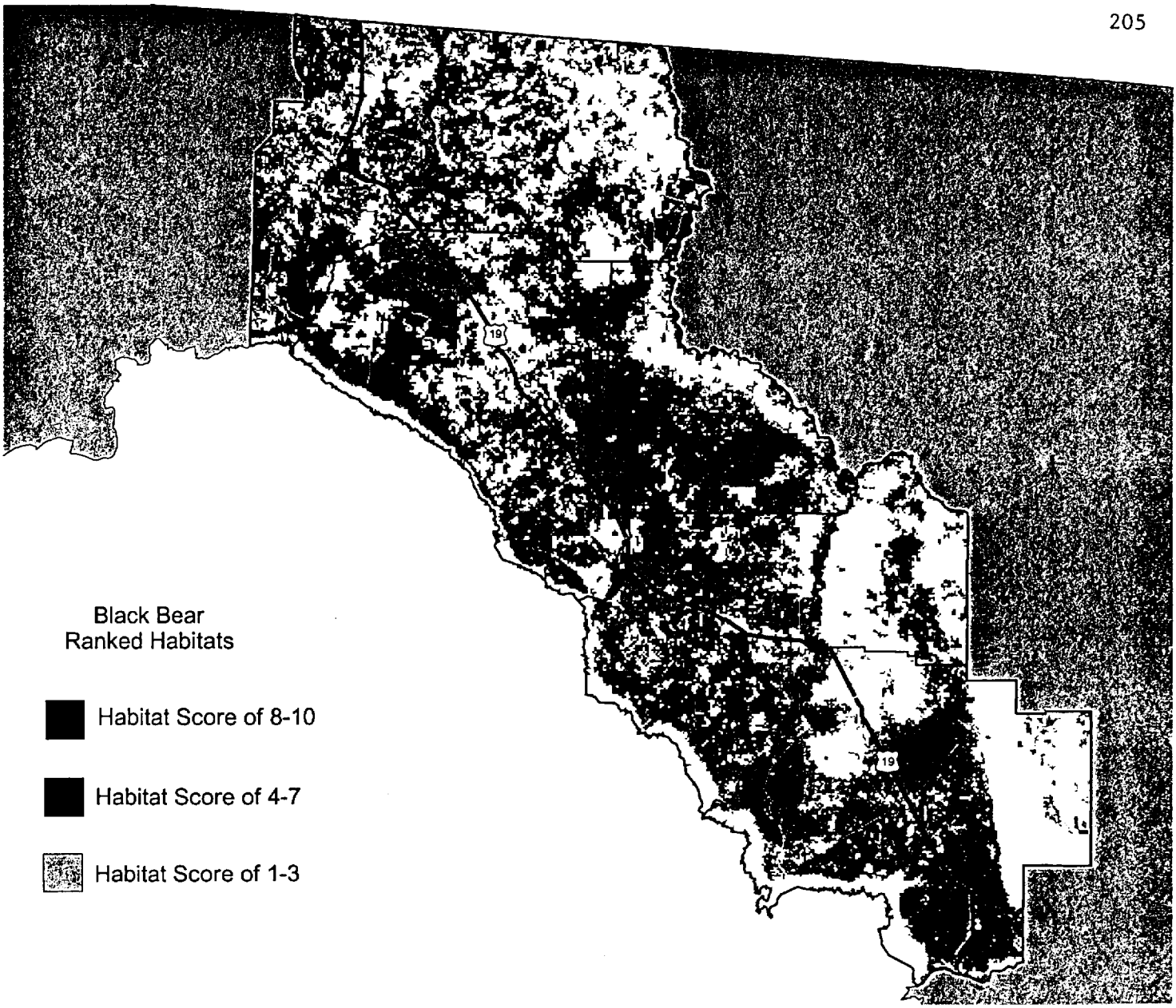

Figure 6. Florida black bear habitats ranked in terms of habitat quality, proximity to public lands, presence of large landownerships, and road density. Highest scores are highest ranked habitats.

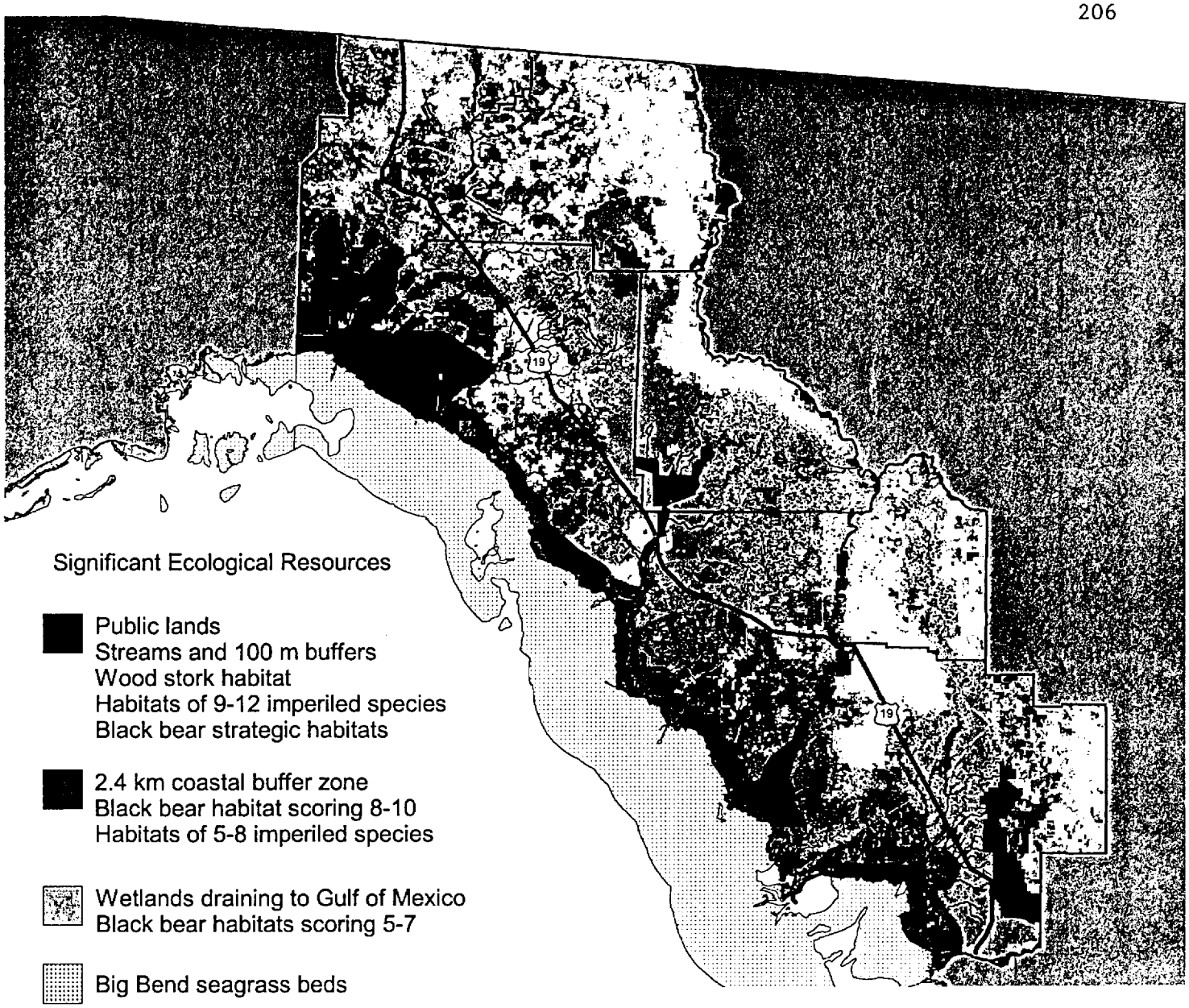

Figure 7. Ecologically significant resources of the Big Bend region of Florida. These are the areas of greatest significance or protection against adverse secondary impacts that will follow increased traffic on US 19 over the next 25 years.

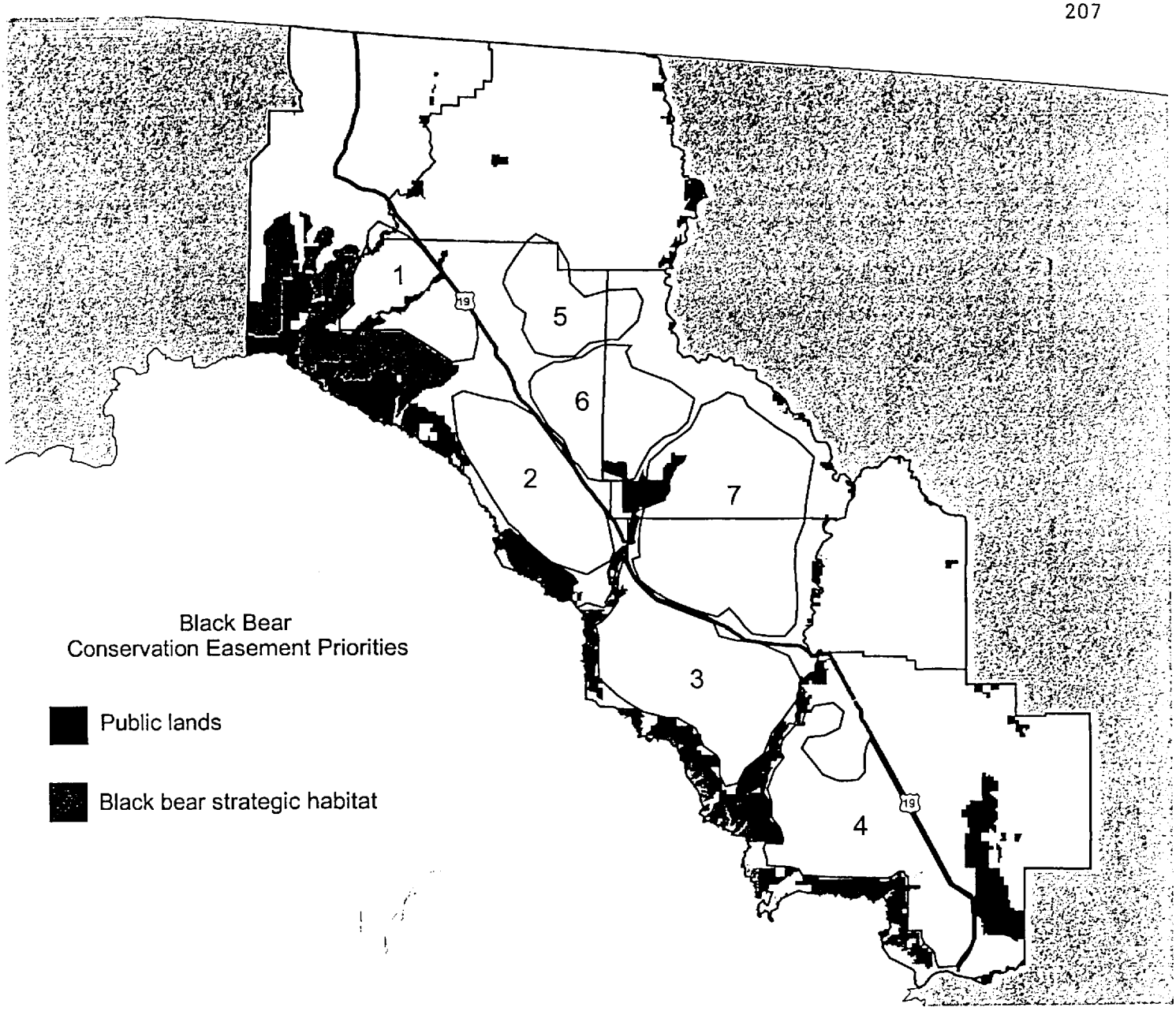

Figure 8. Florida black bear habitat areas ranked in order of priority for conservation easements with timber companies. Conservation easements should be designed to maintain black bear habitats while still allowing for ongoing silvicultural operations.